PAUMIoT: Protocol-Agnostic Universal Middleware for Context-Aware Decision Making in IoT

Abstract

IoT deployments increasingly rely on heterogeneous communication protocols such as MQTT, CoAP, and HTTP, each optimized for different device capabilities and application requirements. In practice, separate ingress paths and static configurations manage these protocols, resulting in operational complexity and suboptimal performance under dynamic network conditions. This proposal presents PAUMIoT, a Protocol-Agnostic Universal Middleware with edge intelligence that unifies multi-protocol ingress and enables safe, adaptive transport selection at the network edge. PAUMIoT decouples protocol detection from protocol selection, allowing incoming traffic to be identified in constant time and processed through a single, scalable pipeline. Transport selection is formulated as an online learning problem and solved using a lightweight contextual bandit deployed directly on resource-constrained devices. A hierarchical safety mechanism enforces non-negotiable constraints, such as battery level and link quality, ensuring predictable behavior during adaptation. We will implement PAUMIoT and evaluate it using ESP32-based clients and a server-side deployment. The experimental results are expected to demonstrate low memory overhead on constrained devices, minimal server-side processing cost, and reduced latency jitter compared to static protocol bindings. Under degraded network conditions, adaptive selection maintains higher message delivery reliability than fixed configurations, confirming the effectiveness of safe edge intelligence for managing protocol heterogeneity in IoT systems.